



Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Lexington, Massachusetts

Agenda

Workshop Theme

CD-ROM Help

Proceedings of the

*Sixth Annual
High Performance Embedded Computing
(HPEC) Workshop*

24–26 September 2002

**Project Report
HPEC-5**

Issued 21 May 2003

ESC-TR-2001-085

K.E. Ballos
Editor

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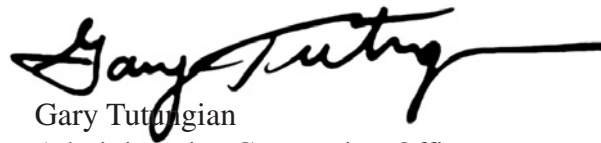
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FOR THE COMMANDER

A handwritten signature in black ink, appearing to read "Gary Tuttingian", with a long horizontal flourish extending to the right.

Gary Tuttingian
Administrative Contracting Officer
Plans and Programs Directorate
Contracted Support Management

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13. ABSTRACT (Maximum 200 words) The focus of this workshop is on high performance embedded computing technologies. The HPEC workshop will give U.S. Government funded researchers from academia, industry, and government, working in this important area, an opportunity to discuss techniques, approaches, and ongoing developments with relevance to real-time embedded military and signal processors. During this sixth year, the HPEC 2002 Workshop will have as its theme novel and emerging architectures for embedded computing. HPEC 2002 continues to provide a forum to present and discuss ongoing advances in these areas, and to gain an understanding of the status and future trends in embedded systems.					
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HPEC 2002

Sixth Annual High Performance
Embedded Computing Workshop

24–26 September 2002

Sponsored by

Dr. Ravindra Athale / DARPA MTO
CAPT Carlton Bourne / U.S. Navy / PMS-422
CAPT Peter Grant / U.S. Navy / PMS-452
Mr. Robert Graybill / DARPA ITO
Mr. Cray Henry / High Performance Computing Modernization Program

<http://www.ll.mit.edu/HPEC>

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LINCOLN LABORATORY
Massachusetts Institute of Technology
Lexington, MA 02420-9108

HPEC 2002 Workshop Organizing Committee

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Mr. Robert Bond / MIT Lincoln Laboratory

Technical Chairman

Dr. Jeremy Kepner / MIT Lincoln Laboratory

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Dr. Ravindra Athale / DARPA MTO

CAPT Carlton Bourne / U.S. Navy / PMS-422

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Dr. Richard Gerber / University of Maryland

Mr. Joe Germann / SKY Computers

Dr. Maya Gokhale / Los Alamos National Laboratory

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2002 High Performance Embedded Computing Workshop Theme

The focus of this workshop is on high performance embedded computing technologies. The HPEC workshop will give U.S. Government funded researchers from academia, industry, and government, working in this important area, an opportunity to discuss techniques, approaches, and ongoing developments with relevance to real-time embedded military and signal processors. During this sixth year, the HPEC 2002 Workshop will have as its theme *Novel and Emerging Architectures for Embedded Computing*.

The workshop organizing committee has assembled a program with a wide breadth of interest. The first day of the workshop starts with a keynote address given by Maj. Gen. Paul Nielsen of Air Force Research Laboratory on **Perspective on Embedded Computing**. The keynote address will be followed by invited speakers, Mr. Zach Lemnios of DARPA / IPTO, discussing *Cognitive Information Processing Technology* and Dr. Thomas Sterling of CalTech / JPL discussing *MIND: Scalable Embedded Computing through Advanced Processor in Memory (PIM) Architecture*. Sessions for this day will be *Novel Hardware Architectures* and *Advanced Hardware Designs*. A poster session is dedicated to hardware architectures and applications. The day will end with a banquet in the Lincoln dining facility with speaker, Cleve Moler of The MathWorks, Inc.

The second day of the workshop begins with invited speaker, Prof. William Dally of Stanford University, discussing *Use of "Streaming" Computation to Build Efficient High Performance Embedded Systems*. Sessions on this day include *Compiler and Library Technologies* and *Emerging High Performance Software*. During this second day, we will have another poster session dedicated to software technologies and systems. The second day will end with invited speaker, Mr. Douglas Schmidt / DARPA / IXO discussing *Designing the Future of Embedded Systems at DARPA IXO*.

The third day of the workshop begins with invited speaker, Dr. Richard Games of MITRE, discussing *Trends in HPC and HPEC Convergence*. Sessions on this day include *Government Sponsored Standards, Industry Sponsored Standards, and System Applications*. During this final day, we will have another poster session dedicated to software / system technologies. The latter portion of the poster session and the last session of the day, *Advanced Systems*, is for **U.S. Citizens Only**.

HPEC 2002 continues to provide a forum to present and discuss ongoing advances in these areas, and to gain an understanding of the status and future trends in embedded systems.

On behalf of the organizing committee, I want to welcome you to the sixth annual HPEC Workshop.

Robert Bond
General Chairman

HPEC 2002 Workshop Agenda

[Tuesday, 24 September](#)
[Wednesday, 25 September](#)
[Thursday, 26 September](#)

Tuesday, 24 September

0730 **Check-In & Continental Breakfast**

AUDITORIUM

0830 **Welcome**
David Briggs / MIT Lincoln Laboratory

0835 **Keynote Address**
Perspective on Embedded Computing
Maj Gen Paul Nielsen / AFRL

0905 **Opening Remarks**
Robert Bond / Jeremy Kepner / MIT Lincoln Laboratory

0915 **Session 1: Novel Hardware Architectures**
David Martinez / MIT Lincoln Laboratory
Presentation: [PDF](#) | [Powerpoint](#)

0925 **Invited Speaker**
Cognitive Information Processing Technology
Zach Lemnios / DARPA / IPTO
Presentation: PDF | [Powerpoint](#)

0955 **Invited Speaker**
MIND: Scalable Embedded Computing Through Advanced Processor in Memory (PIM) Architecture
Thomas Sterling / CalTech / JPL
[Abstract](#) | Presentation: [PDF](#) | Powerpoint

1025 **Break**

Poster Session A Précis

- Poster A.1 **A High Speed Signal Processing System**
Anders Ahlander / Ericsson Microwave Systems
Anders Astrom / Ericsson Microwave Systems
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster A.2 **An Innovative High Performance Architecture for Vector and Matrix Math Algorithms**
Vera Anantha / Intrinsity, Inc.
Christophe Harle / Intrinsity, Inc.
Tim Olson / Intrinsity, Inc.
George Yost / Intrinsity, Inc.
Art Parmet / Intrinsity, Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster A.3 **Real-Time Geo-Registration on High-Performance Computers**
Alan Chao / ALPHATECH, Inc.
Monica Burke / ALPHATECH, Inc.
Thomas Kurien / Mercury Computer Systems, Inc.
Luke Cico / Mercury Computer Systems, Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster A.4 **Algorithmic Advances for Software Radios**
Matteo Frigo / Vanu Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#)
- Poster A.6 **The Raw Microprocessor: Enabling Embedded Signal Processing on a General Purpose Computer Architecture**
Hank Hoffmann / MIT
Volker Strumpfen / MIT
Anant Agarwal / MIT
[Abstract](#) | [Précis](#) | Presentation: [PDF](#)
- Poster A.7 **A Study of the Common Component Architecture (CCA) Forum Software**
Daniel Katz / Jet Propulsion Laboratory / Caltech
Robert Tisdale / Jet Propulsion Laboratory / Caltech
Charles Norton / Jet Propulsion Laboratory / Caltech
[Abstract](#) | [Précis](#) | Presentation: [JPEG](#)

- Poster A.8 **Signal Processing Architectures for Ultra-Wideband Wide-Angle Synthetic Aperture Radar Applications**
Atindra Mitra / AFRL
Joseph Germann / SKY Computers, Inc.
John Nehrbass / Ohio State University
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster A.9 **Implementing Image Processing Pipelines in a Hardware / Software Environment**
Heather Quinn / Northeastern University
Miriam Leeser / Northeastern University
Laurie Smith-King / College of the Holy Cross
[Abstract](#) | [Précis](#) | Presentation: [Powerpoint](#)
- Poster A.10 **Adaptive Framework for Automated Mapping and Architecture Trades for Embedded Heterogeneous Systems**
Raju Venkataramana / Tandel Systems, LLC
Joseph Philipose / Tandel Systems, LLC
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1235 **Lunch**
- 1345 **Session 2: Advanced Hardware Designs**
Maya Gokhale / Los Alamos National Laboratory
Presentation: [PDF](#) | [Powerpoint](#)
- 1355 **Adaptive Beamforming using QR in FPGA**
Richard Walke / QinetiQ LTD
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1425 **Power Consumption of Customized Numerical Representations for Audio Signal Processing**
Roger Chamberlain / Washington University
Yen Hsiang Chew / Washington University
Varuna DeAlwis / Washington University
Eric Hemmeter / Washington University
John Lockwood / Washington University
Robert Morley / Washington University
Ed Richter / Washington University
Jason White / Washington University
Huakai Zhang / Washington University
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

- 1455 **A Library of Parameterized Hardware Modules for Floating-Point Arithmetic and Its Use**
Miriam Leeser / Northeastern University
Pavle Belanovic / Northeastern University
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1525 **Break**
- 1550 **Generation of Custom DSP Transform IP Cores: Case Study Walsh-Hadamard Transform**
Fang Fang / Carnegie Mellon University
James Hoe / Carnegie Mellon University
Markus Pueschel / Carnegie Mellon University
Smarahara Misra / Carnegie Mellon University
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1620 **A Comparison of Two Computational Technologies for Digital Pulse Compression**
Michael Bonato / Catalina Research Inc.
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1650 **Adjourn**
- 1700 **Reception**
- 1800 **Banquet Speaker**
50 Years of Mathematical Software
Cleve Moler / The MathWorks, Inc.
- 1845 **Banquet**

Wednesday, 25 September

- 0730 **Check-In & Continental Breakfast**

AUDITORIUM

- 0830 **Announcements**
Robert Bond / Jeremy Kepner / MIT Lincoln Laboratory
- 0835 **Invited Speaker**
Use of "Streaming" Computation to Build Efficient High-Performance Embedded Systems
William Dally / Stanford University
Presentation: [PDF](#)

0905	Session 3: Compiler and Library Technologies Joseph Germann / SKY Computers, Inc. Presentation: PDF
0915	Short Vector SIMD Code Generation for DSP Algorithms Franz Franchetti / Technical University of Vienna Markus Pueschel / Carnegie Mellon University Jose Moura / Carnegie Mellon University Christoph Ueberhuber / Technical University of Vienna Abstract Presentation: PDF Powerpoint
0945	sc2 C-to-FPGA Compiler Maya Gokhale / Los Alamos National Laboratory Jan Stone / Stone Ergonaut Jan Frigo / Los Alamos National Laboratory Christine Ahrens / Los Alamos National Laboratory Abstract Presentation: PDF Powerpoint
1015	Break
1030	Monolithic Compiler Experiments using C++ Expression Templates Lenore Mullin / MIT Lincoln Laboratory Edward Rutledge / MIT Lincoln Laboratory Robert Bond / MIT Lincoln Laboratory Abstract Presentation: PDF Powerpoint
1100	Streaming and Dynamic Compilers for High Performance Embedded Computing Peter Mattson / Reservoir Labs, Inc. Jonathan Springer / Reservoir Labs, Inc. Charles Garrett / Reservoir Labs, Inc. Richard Lethin / Reservoir Labs, Inc. Abstract Presentation: PDF Powerpoint
1130	Poster / Demo B: Software Technologies and Systems Robert Bernecky / NUWC Presentation: PDF Powerpoint

Poster Session B Précis

Poster B.1	An Integrated Design Environment to Evaluate Power/Performance Tradeoffs for Sensor Network Applications Amol Bakshi / University of Southern California Jingzhao Ou / University of Southern California Viktor Prasanna / University of Southern California Abstract Précis Presentation: PDF Powerpoint
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- Poster B.2 **Distributed Data Management Architecture for Embedded Computing**
Hans-Werner Braun / University of California
Todd Hansen / University of California
Bertram Ludaescher / University of California
John Orcutt / Scripps Institute of Oceanography / UCSD
Arcot Rajasekar / University of California
Frank Vernon / Scripps Institute of Oceanography / UCSD
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster B.3 **Application of Operating System Concepts to Coordination in Pervasive Sensing and Computing Systems**
Jesse Davis / University of Kansas
Joseph Evans / University of Kansas
Benjamin Ewy / Ambient Computing, Inc.
Larry Sanders / Ambient Computing, Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster B.4 **Taskrunner: A Method for Developing Real-Time System Software**
Louis Hebert / MIT Lincoln Laboratory
[Abstract](#) | [Précis](#) | Presentation: [PDF](#)
- Poster B.5 **Software Centric Optimization of a Real-Time Embedded System**
Max Lee / Raytheon
Marshall Moluf / Raytheon
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster B.6 **High Application Availability**
Stephen Paavola / SKY Computers, Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster B.7 **Design Space Exploration and Optimization of Embedded Cache Systems via a Compiler**
Krishna Palem / Georgia Institute of Technology
Rodric Rabbah / Georgia Institute of Technology
[Abstract](#) | [Précis](#) | Presentation: [Powerpoint](#)
- Poster B.8 **Resource Management for Digital Signal Processing via Distributed Parallel Computing**
Albert Reuther / MIT Lincoln Laboratory
Joel Goodman / MIT Lincoln Laboratory
[Abstract](#) | [Précis](#) | Presentation: [PDF](#)
- Poster B.10 **Multidimensional Performance Modeling for Advanced, Embedded, Signal Processors**
Michael Stebnisky / Lockheed Martin
Carl Hein / Lockheed Martin
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)

- Poster B.11 **Rapid Portable Signal Processing Software Development Architecture**
Kevin Tirko / Pennsylvania State University
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster B.12 **Real-Time Linux**
Andrew Webber / Sky Computers, Inc.
Stephen Paavola / SKY Computers, Inc.
[Abstract](#) | [Précis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1225 **Lunch**
- 1335 **Session 4: Emerging High Performance Software**
David Cousins / BBN Technologies
Presentation: [PDF](#) | [Powerpoint](#)
- 1345 **AltiVec Extensions to the Portable Expression Template Engine (PETE)**
Edward Rutledge / MIT Lincoln Laboratory
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1445 **300x Matlab**
Jeremy Kepner / MIT Lincoln Laboratory
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1515 **Break**
- 1540 **Rapid Prototyping of Matlab / Java Distributed Applications using the JavaPorts Components Framework**
Elias Manolakos / Northeastern University
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1610 **Meeting the Demands of Changing Operating Conditions at Runtime Through Adaptive Programming Techniques for Network Embedded Computing**
Richard Schantz / BBN Technologies
Joseph Loyall / BBN Technologies
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1640 **Applying Model-Integrated Computing and DRE Middleware to High Performance Embedded Computing Applications**
Douglas Schmidt / DARPA / IXO
Aniruddha Gokhale / Vanderbilt University
Christopher Gill / Washington University
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1710 **Invited Speaker**
Designing the Future of Embedded Systems at DARPA IXO
Douglas Schmidt / DARPA / IXO
Presentation: [Powerpoint](#)

1740 **Adjourn**

Thursday, 26 September

0730 **Check-In & Continental Breakfast**

AUDITORIUM

0830 **Announcements**
Robert Bond / Jeremy Kepner / MIT Lincoln Laboratory

0905 **Session 5: Government Sponsored Standards**
Edward Baranoski / MIT Lincoln Laboratory
Presentation: [PDF](#) | [Powerpoint](#)

0920 **Development Status of the Vector, Signal, and Image Processing Library (VSIPL)**
Mark Richards / Georgia Institute of Technology
Dan Campbell / Georgia Tech Research Institute
Randall Judd / SPAWAR
James Lebak / MIT Lincoln Laboratory
Rick Pancoast / Lockheed Martin
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

0935 **VSIPL++: Intuitive Programming Using C++ Templates**
Mark Mitchell / CodeSourcery, LLC
Jeffrey Oldham / CodeSourcery, LLC
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

0950 **Data Reorganization Interface (DRI)**
Kenneth Cain, Jr. / Mercury Computer Systems
Anthony Skjellum / MPI Software Technology
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

1005 **Software Communications Architecture Compliant Software Defined Radios**
S. Murat Bicer / Mercury Computer Systems
Jeffrey Smith / Mercury Computer Systems
[Abstract](#) | Presentation: [____](#) [Powerpoint](#)

1020 **Break**

1035 **Session 6: Industry Sponsored Standards**
Craig Lund / Mercury Computer Systems
Presentation: [PDF](#) | [Powerpoint](#)

1050 **Progress in Standardization of RDMA Technology**
Arkady Kanevsky / Network Appliance, Inc.
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

- 1105 **VXS - A Novel and Emerging Architecture for Embedded Computing**
Jeffrey Harris / Motorola Computer Group
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1120 **Status and Activity in the OMG Relevant to HPEC**
James Kulp / Mercury Computer Systems
[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1135 **Poster / Demo C: Software / System Technologies**
Brian Sroka / MITRE

Poster Session C Précis

- Poster C.1 **A Comparison of Java RMI, CORBA, and Web Services Technologies for Distributed SIP Applications**
Mark Hanes / Ohio State University
Stan Ahalt / Ohio State University
Ashok Krishnamurthy / Ohio State University
[Abstract](#) | [Precis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster C.2 **Distribued Embedded Computing in the Detection of Explosives**
Seemeen Karimi / Analogic Corporation
Barry Jackson / SKY Computers, Inc.
Carl Crawford / Analogic Corporation
[Abstract](#) | [Precis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster C.3 **What is Keeping Hard Real-Time Scheduling from being a Mainstream Technology in the Embedded Multiprocessing Domain Space?**
Daniel Lorts / University of Texas at Dallas
[Abstract](#) | [Precis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster C.5 **VSIPL, from API to Product**
Sharon Sacco / SKY Computers, Inc.
[Abstract](#) | [Precis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- Poster C.7 **National Weather Radar Testbed System Implemented Using COTS and VSIPL**
Bob Walsh / SKY Computers, Inc.
James Hunziker / Lockheed Martin
Tim Maese / Lockheed Martin
Walter Mazur / Lockheed Martin
Wayne Sabin / Lockheed Martin
[Abstract](#) | [Precis](#) | Presentation: [PDF](#) | [Powerpoint](#)
- 1230 **Lunch**

1340

Session 7: System Applications

Miriam Leeser / Northeastern University

Presentation: [PDF](#) | [Powerpoint](#)

1350

Missile Seeker Common Computer Signal Processing Architecture for Rapid Technology Upgrade

Daniel Rabinkin / MIT Lincoln Laboratory

Edward Rutledge / MIT Lincoln Laboratory

Paul Monticciolo / MIT Lincoln Laboratory

[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

1420

Hybrid QR Factorization Algorithm for High Performance Computing Architectures

Peter Vouras / Naval Research Laboratory

Gerard Meyer / Johns Hopkins University

[Abstract](#) | Presentation: [PDF](#) | [Powerpoint](#)

1450

Partitioning Computational Tasks within an FPGA + RISC Heterogeneous Multicomputer

John Bloomfield / Mercury Computer Systems, Inc.

[Abstract](#) | Presentation: [PDF](#)

1520

Break

1555

HPEC-SI Demonstration: Common Imagery Processor - APG-73 Image Formation

Brian Sroka / MITRE

[Abstract](#)

1625

High Bandwidth Reconfigurable Embedded Daughter Card Accelerator

Larry Elcessor / Northrop Grumman

Geoffrey Weiss / Northrop Grumman

Michael Lucas / Northrop Grumman

[Abstract](#)

1655

Adjourn